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ASSESSING SOIL PHYSICO-CHEMICAL STATUS OF SAHASTRADHARA LIMESTONE MINE AREA, DOON VALLEY, SHIVALIK HIMALAYAS

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ABSTRACT:

The present study was conducted on assessing soil physico chemical status of Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas at different soil depth (0-15 and 15-30 cm) of four different sites. The analyzed indicate the soil Ph was acidic in all sites. There was an urgent need for rehabilitating of the degraded land and to restore the ecosystem. The results indicate that each range shows a close affiliation to variable soil properties.

KEYWORDS: *Electrical Conductivity (E.C), pH, Soil Organic Carbon (SOC).*

INTRODUCTION:

Mining is the process of extraction of minerals from the earth's crust. It is an intensive type of land use with potential for environmental impact over a limited area. It provides raw materials for various industries and helps in building up the national economy, the adverse environmental impacts of this industry cannot be under estimated. Nearly one million hectare of land in India is presently under the stress of mining activities of various kinds. The much larger area is disturbed by other activities associated with mining. Mining causes the destruction of the natural ecosystem through removal of soil and vegetation and burial beneath waste disposal sites. Mining is an inherently invasive process that can cause damage to a landscape in an area much larger than the mining site itself. The effect of this damage continues year after a mining shut down which includes an addition to greenhouse gases, the death of flora and fauna, and erosion of land and habitat. Moreover, most modern mining techniques have high water demand for extraction processing and waste disposal. Waste water from these processes can pollute water sources nearby and deplete fresh water supply in the region surrounding the mine (Oh *et al.,* 2013). The restoration of mine land in practise can largely be considered as an ecosystem reconstruction and restore the capability of the land to capture and retain fundamental resources. However, monitoring and management are essential as the uncertainties in restoration planning can never be overcome.

The restoration of mine land in practice can largely be considered as ecosystem reconstruction and restore the capability of the land to capture and retain fundamental resources. In ecological restoration planning, it is imperative that goals, objective and success criteria are clearly established to allow the restoration to be undertaking in systematic way, while realizing that these may require some modification later in light of the direction of the restoration succession. However, monitoring and management are essential, as the uncertainties in restoration planning can never be overcome. Ecological restoration may include the management of all types of physical chemical and biological disturbances of soil such as soil pH, fertility, microbial community and various soil nutrient cycles that makes the degraded land into productive on the productive ecosystem become a sources livelihood to the dependent population through providing tangible (fuel, fodder, timber, medicine), and intangible (purifying air and water, detoxifying and decomposition of wastes regulation of climate.

Therefore, this study was a preliminary assessment of Eco-restoration program in relation to soil fertility status with an objective to characterize the soil properties and identify the Soil Physico-chemical status of Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas.

MATERIALS AND METHODS:

Site Description:

The present study was carried out in the mined area in Sahastradhara situated about 18 km from Dehradun on the bank of Baldi River at an altitude of about 800 meters on the same aspect on Mussoorie hills. Sahastradhara laterally meaning the thousand-fold spring. The area situated between $30^0$23'N and $7^0$8'N towards north-east of Dehradun between 1000 m – 1200 m above mean sea level. The topography of the area is a typical valley like. It is surrounded by hills on three sides and a broad river bed on the fourth side. The slopes are steep with an average slope of about 50%. The area was being quarried for limestone for last 30 years. Limestone was extracted from mines by surface mining. Activities have now been abandoned. Eco-restoration work in these mines was carried out in the years 1989-90,1990-91 and respectively so that they had a restoration age of 25,24 and 23 years respectively.

The study area lies in great Himalayan formation with rocks consisting mostly of very friable jointed phyllites, shales, slates, limestone and quartzites. Limestone leads to the formation of calcareous clayey soils, shales and phyllites result in the formation of non-calcareous fine loam to clayey soils, while shallow and coarse textured soils are the products of quartzites (Anatharaman, 1984). The phyllite contains chlorite and calcium chloride and when soaked in water, it swells and the whole rock becomes heavy and slips down due to gravitational force. The climate of the Sahastradhara has well demarcated summer, rainy and winter seasons. Because of the elevation of this site and its location in Doon valley, summer is not very hot which is followed by pre-monsoon and local showers. Monsoon breaks towards the end of June and continues up to September. The average annual rainfall is 3000 mm, 80% of which is received during the monsoon months (mid June-September). The maximum temperature during study period was 30.5°C and minimum temperature was 13.4°C, whereas the relative humidity was 76% during the study period. The soil texture of Sahastradhara varies from sandy loam, loamy sand, red loam, and brown forest soil and pod sols are neutral in reaction. Sahasradhara region is rich in sulphur deposits especially in some of the nearby hills. The area has a diverse biodiversity, the forest types vary greatly ranging from temperate moist forest to tropical dry-deciduous under northern tropical dry mixed deciduous type (Champion and Seth, 1968). Most of the forests are in the degraded state due to heavy anthropogenic pressure. The forests are open and heavily grazed. In the natural forests area of division some of the flora and fauna found are. The area lies in the sub tropical climate and on account of the high rainfall and edaphic factors; there is luxuriant growth of mixed deciduous vegetation except in the areas of biotic interference (mining) etc.

Soil collection and preparation of soil sample

Soil sample was collected randomly from the experimental site, top layer of un-decomposed litter was removed and the samples were collected from the depth of 0-15, and 15-30 cm in each case. The surface of the soil is scraped by Phawraah or Spade. The weeds or surface litter were removed by khurpi. A 'V-shaped' pit is dug by Phawraah up to the required depth i.e. 0 to15 cm, 15 to 30 cm in the study area. Then, the slices of one to two cm thickness are removed from lighter one side or both side of the pit. The entire soil sample is collected in a container; soil sample from all spot is collected during May, 2016 and mixed. Now the resultant soil sample is called composite soil sample. In order to assess the available nutrient in the soil. Soil samples were air-dried and processed as per standard methods in the laboratory. Stones and plant fragments were removed from forest soil by passing the dried grounded soil samples through a 2mm sieve. All the samples were then stored in a polythene container and kept ready for analysis (Singh *et al.,* 2002) with labels and laboratory analysis of soil samples in three replications was carried out afterward.

Physico-chemical analysis of soil

Determination of Colour

Soil colour is commonly and widely determined by Munsell soil colour chart (Munsell colour company, 1994).

Determination of pH and EC

pH of the soil is determined by a pH meter and EC (Electrical Conductivity) by conductivity bridge (APHA, 2011).

Determination of bulk density

Soil bulk density was estimated by Black method (1965).

Water holding capacity

Water holding capacity was estimated by Black method (1965).

Determination of carbon content

Organic carbon was determined by Walkley and Black titration method (Black, 1965).

Determination of available N, P, K

Available N of the soil was determined by alkaline $KMnO_4$ method (Subhiah and Asija, 1956). Available P was estimated using Olsen's extractant (Jackson, 1973) and available K was determined using ammonium acetate extractant (Jackson, 1973).

RESULTS AND DISCUSSION:

The result for the different soil parameters are given in below table. Physical analysis is given in table.1 and chemical analysis results is given in table.2.

Soil is one of the important parameters for eco-restoration of an area. So it needs to analysis in the initial phase of restoration projects, and applies the scientific approach according to the soil quality. Soil bulk density recorded increases with the increase of soil depth.. The bulk density of soils ≤ 1.5 gm/cm^3 indicate good for soil quality and more than 1.5gm/cm^3 leads adverse impacts. The bulk density of study area 1 (1.65 gm/cm^3) has a minimum range, and bulk density of site 2 (1.66 gm/cm^3) or site 3 also (1.66 gm/cm^3) has maximum bulk density.

Soil water holding capacity is controlled primarily by the soil texture and the soil organic matter content. Soil texture is a reflection of the particle size distribution of a soil. An example is a silt loam soil that has 30% sand, 60% silt and 10% clay sized particles. In general, the higher the percentage of silt and clay sized particles, the higher the water holding capacity. The small particles (clay and silt) have a much larger surface area than the larger sand particles. This large surface area allows the soil to hold a greater quantity of water. The amount of organic material in a soil also influences the water holding capacity. As the level of organic matter increases in a soil, the water holding capacity also increases, due to the affinity of organic matter for water. Water holding capacity of site 3 sample contains high amount of water. Comparatively to other plots 1, 2 and 4 the average of W.H.C is 48.3% and it is good for plants.

Soil colour was influenced by the amount of mineral present in the soil. According to sample the colour of soil is mostly dark gray, gray, dark brown & brown. Therefore, soil contains high organic matter.

The pH of soil or more precisely the pH of the soil solution is very important because soil solution carries in it nutrients such as nitrogen, potassium, and phosphorus that plants need in specific amounts to grow, thrive, and fight off diseases. pH range of 6.5 to 7,5 is optimal for plant nutrient availability. If the soil solution is to acidic plants cannot utilize N, P, K and other nutrients needed. In acidic soils, plants are more likely to take up toxic metals and some plants eventually die of toxicity. The pH of site 4 soil is (6.55 and 6.79) and all of soil samples of site 1, site 2 and 3 are showing average 7.30. The soil of the area was acidic due to rapid weathering and intense leaching under high rainfall condition factors for the development of soil acidity and also an effect of geological and environmental factors. Land use pattern and uncontrollable climate change (Patil, 2014).

Soil electrical conductivity correlates very strongly with particle size and soil texture. Soils prone to drought or excessive water will show variations in soil texture that can be delineated using soil electrical conductivity. In the soil, the Electrical Conductivity (EC) reading shows the level of ability the soil water has to carry an electrical current. The EC levels of the soil water is a good indication of the amount of nutrients available for your crops to absorb. EC of site 3 samples contain more ions (67.41 µs & 73.93µs). And average of all sites 1, 2, 3, and 4 is 54.90 µs.

The effect of soil organic matter (SOM) on soil is well recognized. SOM plays a vital role in supplying plants nutrients, cation exchange capacity, improving soil aggregation and hence water retention and soil biological activities. Soil analysis reveals that site 4 carrying maximum C% it varies with depth of site 4A sample depth is 0-15cm has 1.52% and 4B sample depth is 15-30cm has 1.47% of carbon. 4A sample has more C% and average is 1.49% compared to another sample of site 1, 2 and 3. And average of all samples is 1.10%.

Available nitrogen percentage in site 3 sample (0.36% and 0.30%). It contains more nitrogen comparatively to other sites 1, 2, and 4. Average of all samples is 0.027%. Percentage of phosphorus in soil of site 3 samples 3A contain 0.0037% and 3B contains 0.0030% of phosphorus and average of all plots is 0.0026%. Available potassium content in these soil site 3 contains (0.029% and 0.024) maximum % of potassium, and all samples of site 1, 2, 3 and 4, an average is 0.024%. Variation in the soil nutrients across the sites may be due to natural and human driven factors or human actions (Bhandari, 2004; Sahani, 2016)

CONCLUSION:

It was concluded that soil under Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas to be acidic. EC of the soil shows ion present in the soil which helps in plant growth, organic carbon in soil available in less quantity. Based on the results it imperative that eco-restoration of these degraded mine area will halt further degradation and present environment quality.

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Table 1. Physical properties of the soil in different depths of Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas

Site No.	Depth of sample (cm)	Bulk density (g/cm³)	Water holding capacity (W.H.C) %	Colour
1A	0-15	1.65	32.9	Dark gray
1B	15-30		37.9	Gray
2A	0-15	1.66	37.4	Light gray
2B	15-30		45.2	Gray
3A	0-15	1.66	69.1	Dark gray
3B	15-30		59.4	Dark gray
4A	0-15		54.5	Brown
4B	15-30	-	50.1	Dark brown

Table 2. Chemical properties of the soil in different depths of Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas

Site No.	Depth of sample (cm)	pH	Electrical conductivity (μs)	Organic carbon (%)	Available		
					N (%)	P (%)	K (%)
1A	0-15	7.52	52.70	0.56	0.031	0.0032	0.021
1B	15-30	7.33	50.11	0.46	0.025	0.0024	0.023
2A	0-15	7.57	47.43	1.28	0.024	0.0027	0.033
2B	15-30	7.63	55.04	0.82	0.021	0.0024	0.014
3A	0-15	7.51	67.41	1.78	0.036	0.0037	0.029
3B	15-30	7.56	73.93	0.92	0.030	0.0030	0.024
4A	0-15	6.55	49.67	1.52	0.028	0.0018	0.026
4B	15-30	6.79	42.98	1.47	0.023	0.0023	0.024

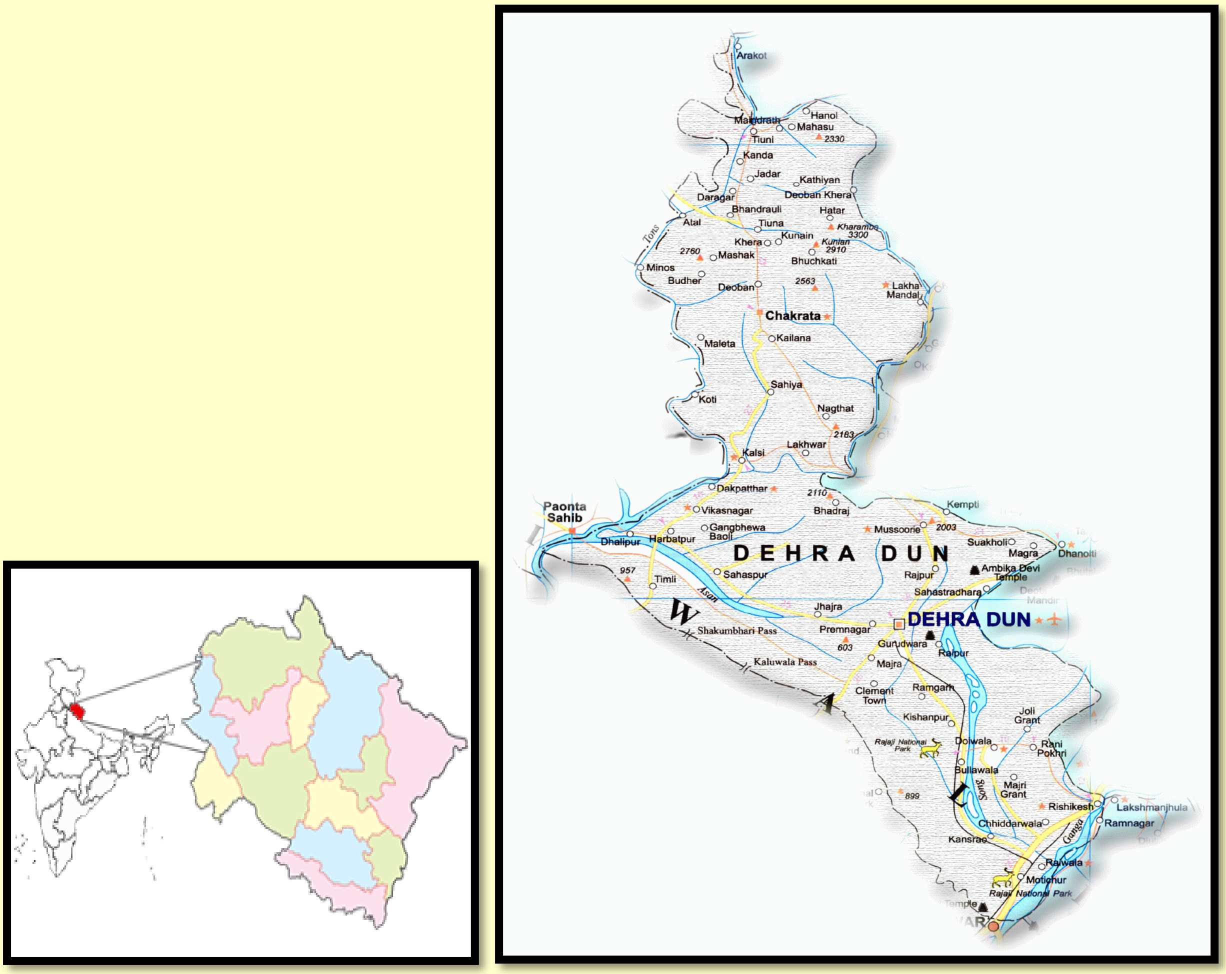

Fig 1. Map (Not to scale) of Sahastradhara limestone mine area, Doon valley, Shivalik Himalayas

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